REMARKS/ARGUMENTS

The Final Office Action dated 5/11/2006 rejected claims 1-11 and 24-28; No claims were allowed.

Claims 1, 2, and 5-11 were rejected under 35 USC § 103(a) as being unpatentable over Calvert et al., (USPN 5,389,496), in view of *ASM Handbook Vol 5*, Porterfield's textbook, *Inorganic Chemistry: A Unified Approach*, and Van Zant's *Microchip Fabrication, Fifth Ed.*

Claims 1, 3, and 4 were rejected under 35 USC § 103(a) as being unpatentable over Schnur et al., (USPN 5,079,600), in view of the basic textbook by Van Zant.

Claims 24-28 were rejected under 35 USC § 103(a) as being unpatentable over Schnur et al., (USPN 5,079,600), in view of the *ASM Handbook* and Porterfield.

By this Amendment, the structures of claims 2, 3, 6 and 7 have been incorporated into claim 1. Claims 2 and 3 are cancelled. Claim 6 has been limited to species reading on subunit 10, page 8 of the specification; claim 7 has been limited to species reading on subunit 5, page 8 of the specification.

Independent claim 24 has been amended to incorporate the limitations of claim 27, which is cancelled. Claims 1, 4-11, 24-26 and 28 remain in the case. Reconsideration and allowance of these claims in view of the following remarks is respectfully requested.

Turning now to the Detailed Action, the following remarks are set forth and responded to in the same order as presented in the Office Action.

1. Claim Objections *(Office Action paragraph 3)*

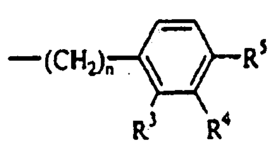
Claim 1 was objected to for lacking a semicolon.

Response

This grammar has been corrected.

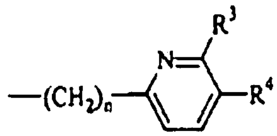
3. Rejection of Claims 1, 2, and 5-11 under 35 USC §103(a) over Calvert et al. 5,389,496 in view of ASM Handbook, Porterfield and Van Zant *(Office Action paragraphs 4-5)*

The Office Action states that Calvert et al. discloses a method for forming a diffusion barrier according to the steps of claim 1 (now amended).

> The Office Action states:
>
> "Calvert et al. does not disclose that the metal layer is formed using a vapor deposition process, or that said diffusion barrier inhibits copper diffusion in the substrate....**It would have been obvious to one of ordinary skill in the art at the time of invention to use a vapor deposition method such as sputtering [in place of electroless metallization]** because Van Zant teaches that sputtering provides conservation of target material composition, uniform step coverage and uniform film formation [see p. 421].
>
> Regarding claim 6, the prior art of Calvert et al, ASM Handbook, Porterfield and Van Zant disclose the method according to claim 2 as described above. Furthermore, Calvert et al. discloses wherein R^2 is an alkyl group of the following structure:
>
> 
>
>
> wherein R3, R4 and R5 are hydrogen, and wherein n is 1 [see Example 19 (4- chloromethylphenyltrimethoxysilane)) .
>
> Regarding claim 10, the prior art of Calvert et al, ASM Handbook, Porterfield and Van Zant disclose the method of claim 7 as described

above. Furthermore, Calvert et al. discloses wherein R3, R4 and R5 are hydrogen, and wherein n is 2 [see Examples 1,2, 11, 19-24,28,29 and 31 (β- trimethoxysilylethyl- 2-pyridine)].

Regarding claim 11, the prior art of Calvert et al, ASM Handbook, Porterfield and Van Zant disclose the method of claim 8 as described above. Furthermore, Calvert et al. discloses wherein R^2 is an alkyl group of the following structure:



and wherein R^3 and R^4 are hydrogen and n is 2 [see Example 4 (3-(trimethoxysilyl) propylamine))].

Response

Regarding Claim 1, it is not obvious to substitute vapor deposition in a reference directed to improvements in electroplating:

Applicants have presented evidence in the form of a declaration under 1.132 that a worker in the field does not consider electroless plating and vapor deposition as obvious equivalents. Furthermore, the process of Calvert et al. is directed to an improvement in electroless plating wherein the terminal groups of the molecular layer provide a means to form the ligating layer for subsequent Cu film nucleation and growth by electroless plating. In other words, the point of Calvert et al. is to provide a ligating layer to ligate a metallization catalyst. A catalyst layer is a necessary condition for film nucleation and growth by electroless deposition, but is not necessary in vapor deposition. Combining prior art which teaches vapor deposition with the process of Calvert et al., to the extent this could be done, would render the method of Calvert et al. inoperable, as there would be no catalyst for the ligating layer to ligate.

McGinley v. Franklin Sports, Inc., 262 F.3d 1339, 1351 (Fed. Cir. 2002) involved a patent to McGinley which claimed an instructional pitching device in the form of a regulation baseball with specific "finger placement indicia" for teaching students

how to grasp a baseball for throwing different types of pitches. In reversing a JMOL of obviousness over references to Pratt and Morgan, the court stated:

> Perhaps McGinley's best argument to save his claims from prima facie obviousness in the light of Pratt and Morgan is his contention that those references together teach away from their combination. We have noted elsewhere, as a "useful general rule," that references that teach away cannot serve to create a prima facie case of obviousness. *In re Gurley*, 27 F.3d 551, 553, 31 USPQ2d 1131, 1132 (Fed. Cir. 1994). If references taken in combination would produce a "seemingly inoperative device," we have held that such references teach away from the combination and thus cannot serve as predicates for a prima facie case of obviousness. *In re Sponnoble*, 405 F.2d 578, 587, 160 USPQ 237, 244 (CCPA 1969) (references teach away from combination if combination produces seemingly inoperative device); see also *In re Gordon*, 733 F.2d 900, 902, 221 USPQ 1125, 1127 (Fed. Cir. 1984) (inoperable modification teaches away).

With regard to the Examiner's responses to Applicants' arguments, it is therefore again pointed out that even, assuming arguendo, that Calvert et al.'s binding layer is the same as the recited diffusion barrier, the two <u>methods</u> are patentably distinct insofar as Calvert et al. are not concerned with diffusion of copper, do not require a monolayer, and do not teach a vapor deposition process, and would be rendered inoperative if a vapor deposition process were used. Calvert et al. are concerned with a completely different problem than the art-recognized problem of diffusion of copper into silicon substrates. Furthermore, the metal layer that results from electroless plating is different than the metal layer that results from vapor deposition, in that the target material is deposited on the wafer (or diffusion barrier) without chemical change of the surface, as taught in Van Zant. On the other hand, electroless plating relies on the formation of a catalytic layer (e.g., Pd) through a chemical reaction with the terminal group of the molecular layer, which can compromise the Cu blocking functionality of the molecular layer. Moreover, the configuration of the sample in this scenario becomes Cu/catalytic-layer/altered-SAM/substrate, where any diffusion barrier properties could be due to the catalytic layer. These features are different from our configuration and

functionality which pertain to Cu/SAM/substrate. Furthermore, electroless plating and vapor deposition yield copper layers with different properties, as shown by the Yin reference, previously provided.

Claims 6 and 9 (dependent from 6) recite materials not disclosed in Calvert et al.

Claim 6 is directed to structures having an aryl copper binding end, which is not taught or suggested by Calvert et al. 4-chloromethylphenyltrimethoxysilane does not possess the recited -(CH2)n- . Furthermore, this compound did not work. See the last line of Example 19.

4. Rejection of Claims 1, 3 and 4 under 35 USC §103(a) over Schnur et al. US 5,079,600 in view of Van Zant (*Office Action paragraph 6*)

The Office Action states:

> Regarding claim 1, Schnur et al. discloses a method for forming a diffusion barrier layer comprising the steps of:
> a) preparing the silicon substrate[see col. 11, lines 24-26];
> b) contacting the silicon substrate with a composition comprising self-assembled monolayer subunits and a solvent [see col. 11, lines 31-36];
> c) removing the solvent [see col. 11, lines 36-39], thereby forming the diffusion barrier; and
> d) forming a metal layer on the diffusion barrier as formed in step (c) [see paragraph bridging columns 7 and 8], said diffusion barrier inhibiting copper diffusion into the substrate [see Example 24].
>
> Schnur et al. does not disclose that the metal layer is formed using a vapor deposition process. Van Zant teaches that vapor deposition process such as sputtering may be used to deposit any material on any substrate [see p. 420]. It would have been obvious to one of ordinary skill in the art at the time of invention to use a vapor deposition method such as sputtering because Van Zant teaches that sputtering provides conservation of target

> material composition, uniform step coverage and uniform film formation [see p. 421].

Response

As discussed extensively below, the process of Schnur et al. and Calvert et al. are separate and distinct from their present process. It would not be obvious to substitute vapor deposition for electroless plating, because the references are designed as improvements to electroless plating. The Examiner is respectfully requested to consider the enclosed Declaration of G. Ramanath addressing this point.

5. Rejection of claims 24-30 under 35 USC § 103(a) over Schnur et al. in view of ASM Handbook and Porterfield *(Office Action paragraph 7)*

The Office Action states:

> "Schnur et al. discloses a method of forming a device, the method comprising: providing a substrate [see Fig. lA]; **providing a diffusion barrier layer (called "thin film"),** wherein the diffusion barrier comprises a self-assembled monolayer [see col. 10, lines 42-47], wherein the self-assembled monolayer is a single layer of molecules [see col. 7, lines 11-15], and wherein the molecules in the self-assembled monolayer have first ends attached to the substrate and second ends projecting upward from the substrate [see Fig. lA]; and **forming a metal layer on the diffusion barrier layer using a vapor deposition process,** wherein the metal layer is in direct contact with the second ends of the molecules in the self-assembled monolayer [see col. 9, lines 10-17], wherein a seed layer of Pd/Sn is coated over the self-assembled monolayer; see col. 4, lines 14-17, wherein vapor deposition is given as a known method for fabricating metal paths; and see Fig. 3A for the configuration thereof].
>
> **Schnur et al. does not disclose that the metal layer is copper.** ... It would have been obvious to one of ordinary skill in the art at the time of invention to use copper as the metal catalyst in Schnur et al. as taught in the ASM Handbook because Schnur et al. is not limited to Pd/Sn catalysts, and because copper is a known catalyst for electroless copper

plating, as used in Schnur et al, as taught by the ASM Handbook.

Regarding claim 25, it is held absent evidence to the contrary that the diffusion barrier of Schnur et al. is capable of preventing diffusion of metal atoms from the metal layer into the substrate when the semiconductor device is exposed to an electric field of 2 J\1V / cm at about 200° for about 30 minutes. Basis for this reasoning is that Applicant is using the **exact same self-assembling monolayer as is Schnur et al. to form the barrier layer. Schnur et al. also points out in Example 24 that copper diffusion does not occur even under the stress of an electric field.**

Response

(A.) Schnur et al. teach a method for electroless plating, while the claimed methods utilize vapor deposition.

As stated these are completely different processes.

(B) The process of Schnur et al. involves modification of the as-formed SAM.

Schnur et al. teaches modification of their self-assembling film to selectively increase or decrease catalyst binding. This modification involves removal or chemical alteration of a "terminal moiety" as shown in Figs. 2 and 3. This is not, as stated in the Examiner's "Response to Arguments," one embodiment, but rather the whole point of Schnur et al., as indicated by the title of the patent. Additionally, the Pd/Sn catalyst layer that intervenes between the electroless Cu implies a Cu/Pd(or Sn)/monolayer/substrate configuration as opposed to Cu/monolayer/substrate configuration which results from the presently claimed method. In the former configuration, while a Pd (or Sn) catalyst layer is a necessity and the Cu layer is not in direct contact with the molecular layer. In contrast, the presently claimed method recites SAMs with certain terminal groups which have been found to directly block Cu diffusion without the need for any intervening layers which themselves may block Cu diffusion.

(C) Schnur et al. do not teach or suggest vapor deposition. In "Response to

Arguments," Examiner again submits that since vapor deposition is a known alternative process to electroplating, the modification of the SAM layer to make it more compatible for an electroless plating process does not cause the instantly claimed process to be patentably distinguished over the cited prior art. As outlined in the enclosed declaration, vapor deposition is a completely different process than electroless plating. Furthermore, the references do not teach, suggest, or inherently disclose a diffusion barrier, nor do they teach or suggest the use of copper as a metal layer.

D. Claim 24, as amended, recites diffusion barrier molecules having aromatic ends, whereas Schnur et al. teaches various alkyl silanes.

As described above, Schnur et al. teach a wide variety of films which can be irradiated to form the patterns of that invention, because barrier properties are not a concern in the Schnur et al. patent. The examples given for use with silicon are all alkyl silanes.

Schnur et al. Example 24 teaches the use of 4-aminobutyldimethylmethoxysilane (UTF3). This compound is not embraced by the present claims. As stated in the accompanying declaration, the test done in Example 24 does not indicate any practical barrier property, as presented in the previous Amendment.

CONCLUSION

Applicants request that the rejections of claims 1, 2, 4-11, 24-26 and 28 be withdrawn for the reasons advanced above. It is believed that the present Amendment is fully responsive to the presently outstanding Office Action and should place the application in condition for allowance. Reconsideration and allowance of currently pending claims 1, 2 4-11, 24-26 and 28, as well as the timely issuance of a Notice of Allowance is earnestly solicited. The Examiner is respectfully invited to call the undersigned at the number below if the prosecution

of the subject application may be expedited by a telephone conference.

Respectfully submitted,

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